A Look Ahead to April, May and June 2011 For the Front Range and the Rest of Colorado

Mike Baker National Weather Service Boulder, Colorado March 22, 2011



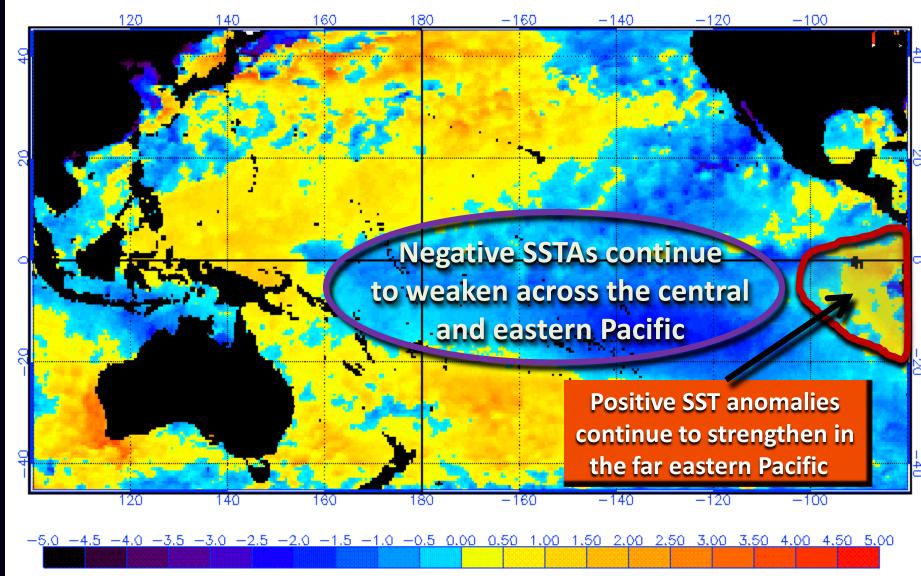


Highlights

- La Niña conditions in the Pacific continues to weaken.
- The current La Niña continues to behave similarly to the last four moderate to strong La Niña events of the past 40 years.
- After a significant cool down in February, particularly in eastern Colorado, temperatures have returned to above average across much of the Centennial State during the month of March.
- The western slope of Colorado continues to receive the lion's share of precipitation, largely in the form of snow, brought by a number of moisture baring Pacific storm systems. Meanwhile, areas predominantly east of the Continental Divide continue to dry out as gusty downslope winds (referred to as Chinook) move down the Front Range mountains and out across the eastern plains.
- The latest outlook from NOAA's Climate Prediction Center (CPC) generally calls for above average temperatures and below average precipitation across Colorado, with the most significant changes anticipated on the state's western slope.

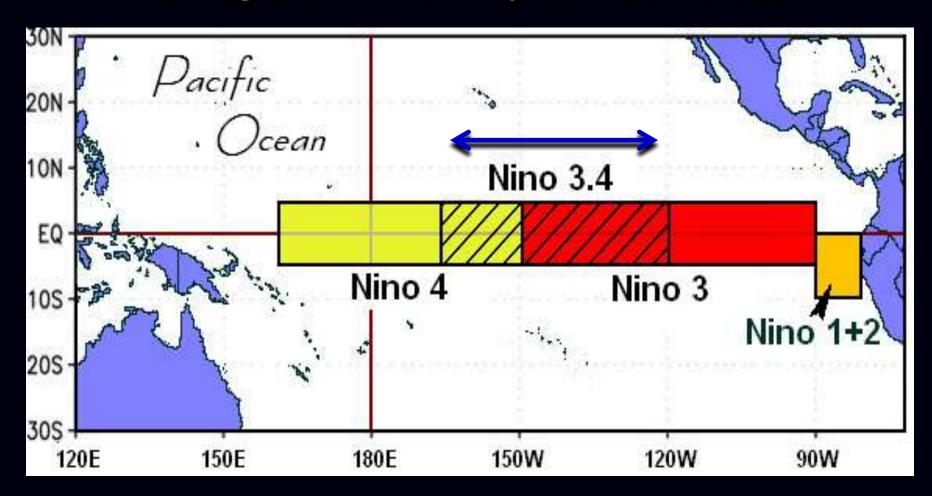


NOAA/NESDIS SST Anomaly (degrees C) for Mar 17, 2011



Sea Surface Temperature Anomaly (deg C)

Niño Regions in the Tropical Pacific Ocean



Nino 3.4 – The principal region in the eastern tropical Pacific used by the Climate Prediction Center (CPC) for monitoring, assessing and predicting ENSO.



Area-Averaged Sea Surface Temperature Anomalies in Degrees C for Pacific Region Nino 3.4 from January 1992 through February 2011

A total of seven El Niños and seven La Niñas of varying strengths have occurred since the winter season of 1991-1992. Noteworthy ENSO events include the strong El Niños during the winter seasons of 1997-1998 and 2009-2010, and the strong La Niñas during the winter seasons 1999-2000 and 2010-2011. The strong La Niña in 1999-2000 fell within an extended period of La Niña conditions that lasted from the fall of 1998 through the spring of 2001.

Oceanic Niño Index (ONI)

- The ONI is based on sea surface temperature (SST) departures from average in the Niño 3.4 region of the Pacific and is a principal measure for monitoring, assessing, and predicting ENSO.
- <u>Defined as the three-month running-mean SST departures in the Niño 3.4</u>
 <u>region</u>
- Used to place current events into a historical perspective
- NOAA's operational definitions of El Niño and La Niña are keyed to the ONI index.

NOAA Operational Definitions for El Niño and La Niña

El Niño: characterized by a positive ONI greater than or equal to +0.5 C.

La Niña: characterized by a *negative* ONI less than or equal to −0.5 C.

By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons.

CPC considers El Niño or La Niña <u>conditions</u> to occur when the monthly Niño3.4 OISST departures meet or exceed +/- 0.5°C along with consistent atmospheric features. These anomalies must also be forecasted to persist for 3 consecutive months.

Oceanic Niño Index - ONI

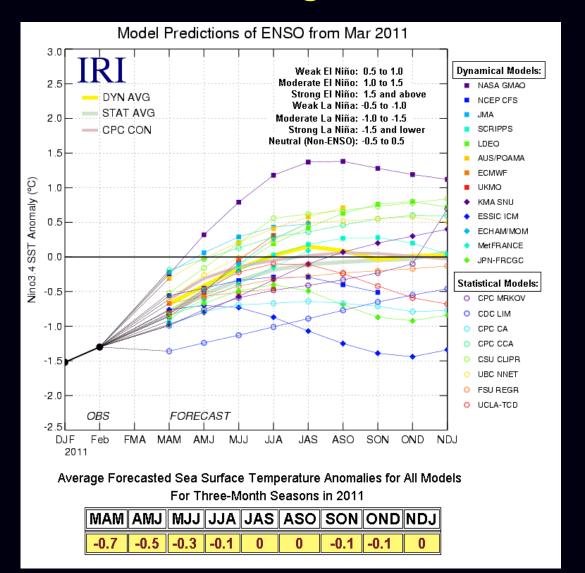
Year	DJF	JFM	FMA	MAM	АМЈ	МЈЈ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.6	-1.4	-1	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1	1.1	1.3	1.5	1.4
2003	1.2	0.9	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.9	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.1	1.1
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1	-1.1	-1.3
2008	-1.4	-1.4	-1.1	-0.8	-0.6	-0.4	-0.1	0	0	0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6	0.7	0.8	0.9	1.2	1.5	1.8
2010	1.7	1.5	1.2	0.8	0.3	-0.2	-0.6	-1.0	-1.3	-1.4	-1.4	-1.4
2010				0.0	0.0		0.0	2.0			2.7	
2011	-1.3			test ON								

Warm Episodes - El Niños: ONI +0.5 and above (red numbers)

Cold Episodes - La Niñas: ONI of -0.5 and below (blue numbers)

Neutral or non-ENSO Episodes: ONI above -0.5 and below 0.5 (black numbers)

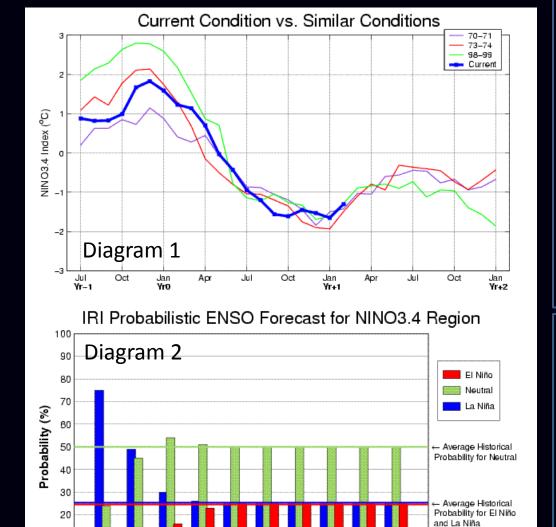
Pacific Region Niño 3.4 ENSO Outlook



- All 23 dynamical and statistical ENSO models continue to forecast further weakening of the negative SST anomalies across the eastern tropical Pacific region Niño 3.4 during the next several months. A majority of the models indicate ENSO neutral (+0.5 C to -0.5 C) conditions by the start of the 2011 summer season.
- Beyond this spring, the models offer a wide range of possibilities; some indicate a weak La Niña, others indicate ENSO-neutral conditions, while others suggest weak El Niño conditions.

Source: International Research Institute for Climate and Society (IRI) – Updated 3/17/11

La Niñas - Past, Present and Future



Source: International Research Institute for Climate and Society (IRI) – Updated 3/17/11

ASO

Time Period

JAS

10

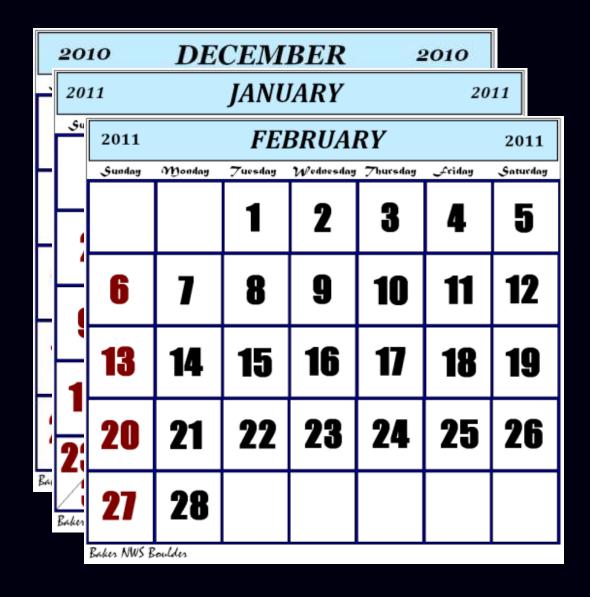
<u>Diagram 1</u>: Shows a comparison of the current La Niña episode to the last four strongest La Niña episodes observed in 1970-71, 1973-74, 1998-99 and 2007-08.

The current La Niña continues to track closely to the previous moderate to strong La Niñas. As of the first of February only the 1973-1974 La Niña was comparatively stronger by only a small margin to the current La Niña. Should the current La Niña perform like those compared to in diagram 1, we would presumably return to weak La Niña conditions by this fall.

Diagram 2: The bar graph depicts the probability of El Niño, La Niña and ENSO-neutral conditions in Pacific Niño Region 3.4 during the next 12 months, based on the latest ENSO model forecasts.

By the summer season of June-July-August, models indicate equal chances for La Niña and El Niño conditions, with no clear preference towards warming or cooling in the SSTs during the remainder of 2011.

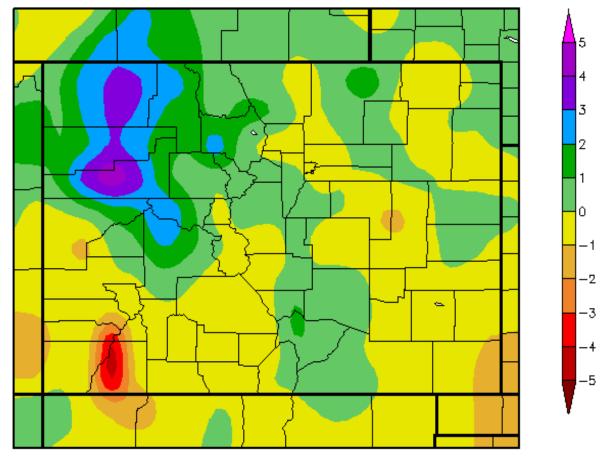




90-Day Review of Temperature, Precipitation, **Snow Pack and Snow-Water** Equivalency Across Colorado

Departure from Normal Preciptation (in inches) For Colorado

Dec. 20, 2010 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

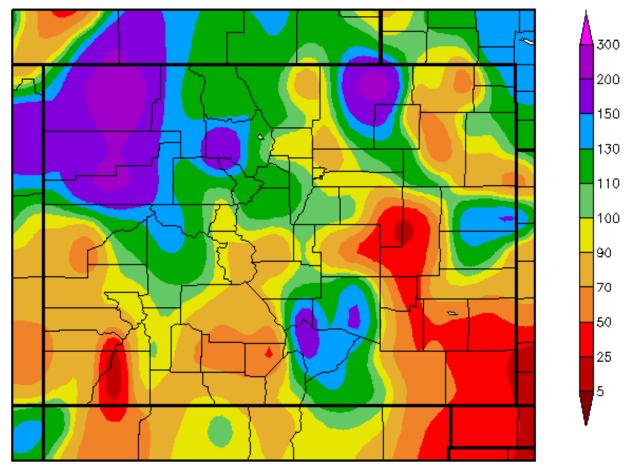
Regional Climate Centers

Above normal precipitation fell across much of northwest and west central Colorado during this three month period, with the greatest departures from normal on the Roan Plateau, Grand Mesa, the West Elk Mountains and the Yampa River Valley.

Below normal precipitation was observed in most of southern and eastern Colorado during the same period. The greatest departure from normal was observed in the Animas River Valley on the south slope of the San Juan Mountains in southwest Colorado.

Percent of Normal Precipitation (%) for Colorado

Dec. 20, 2010 to Mar. 19, 2011



Generated 2/11/2011 at HPRCC using provisional data.

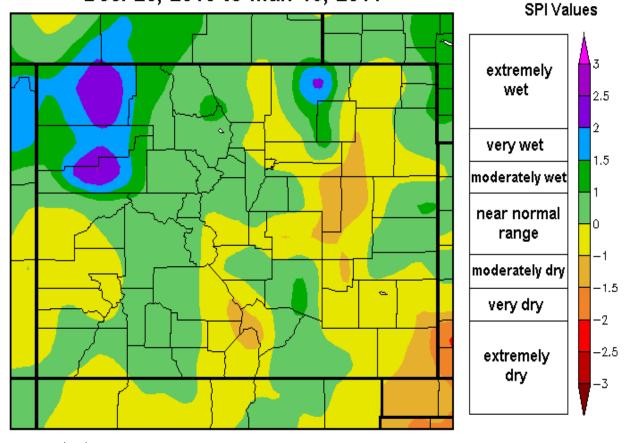
Regional Climate Centers

The northwest corner of Colorado continued to record the greatest percent of normal precipitation during the three month period as indicated by the shades of purple across the region.

The remainder of the state witnessed modest to significant departures from normal precipitation, with the southeast portion of the state recording the greatest deficits.

3-Month Standardized Precipitation Index (SPI) for Colorado

Dec. 20, 2010 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

The Standardized Precipitation Index (SPI)

was developed to
monitor potential short term
agricultural and
long-term hydrological
drought conditions. The
SPI is a probability index
that considers only
precipitation.

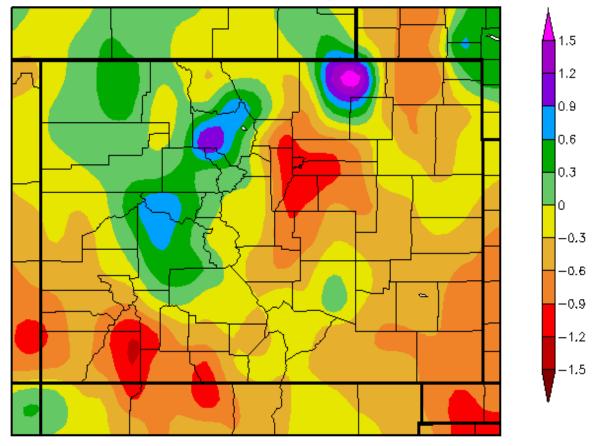
During the 90-day period ending March 19, 2011, the SPI continued to indicate wetter than normal conditions across the northwest, west central and north central portions of the state. The driest conditions persisted east of the Continental Divide, namely along the Palmer Divide east of Denver, the Sangre de Cristo Mountains and the far southeast plains.

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30-Day Review of Temperature, Precipitation, **Snow Pack and Snow-Water** Equivalency Across Colorado

Departure from Normal Precipitation (in Inches) for Colorado

Feb. 18 to Mar. 19, 2011



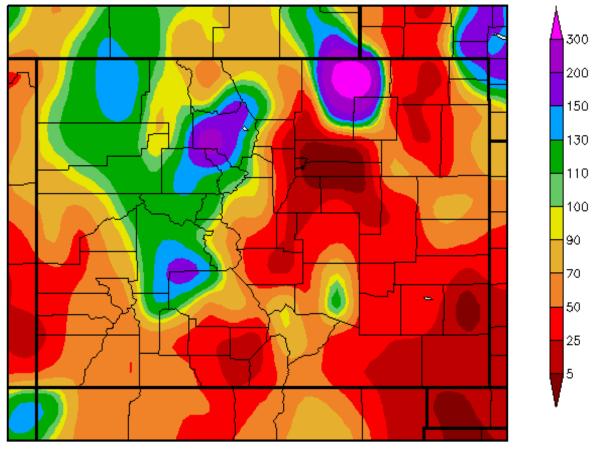
Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

Precipitation, predominantly in the form of snow, continued to run above average across northwest and west central Colorado for the fourth consecutive month. Positive departures from normal decreased, in some areas significantly, from totals observed during the previous 30-day period.

Eastern and southern
Colorado continued to fall
behind in precipitation with
deficits ranging as much as 1.0
to 1.5 inches in the San Juan
Mountains and nearby river
valleys, and in the southern
Front Range/Rampart Range/
Pikes Peak region in east
central Colorado.

Feb. 18 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

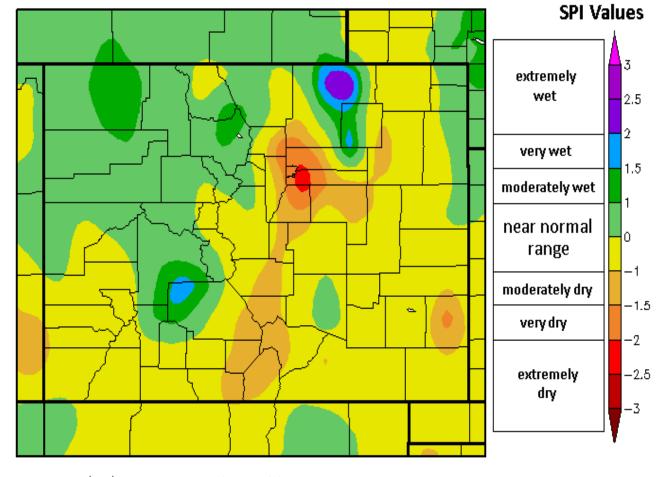
During the 30-day period ending March 19, 2011, precipitation varied from 130 to 300 percent above normal across northwest and west central Colorado.

A second area of above normal precipitation was centered in Weld County in northeast Colorado – a result of a significant snowfall in early March.

Below normal precipitation occurred over the rest of the state with deficits as much as 50% below normal along the Front Range, lower portions of the South Platte River Valley, the Arkansas River Valley in southeast Colorado, and the San Luis Valley in south central Colorado.

30 Day Standardized Precipitation Index (SPI) for Colorado

Feb. 18 to Mar. 19, 2011



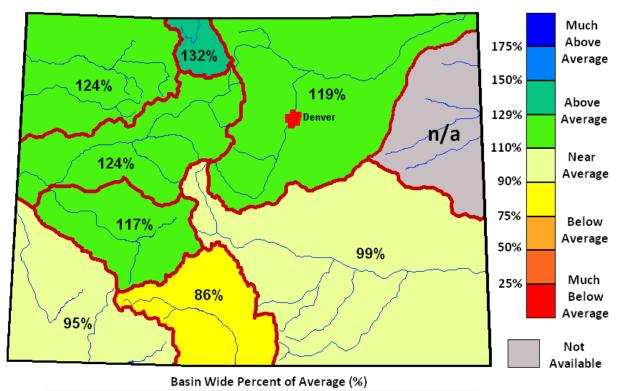
Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

During the 30-day period ending March 19, 2011, the SPI continued to indicate wetter than normal conditions across northwest and west central Colorado, together with portions of northeast Colorado near the Wyoming border, the result of a heavy snowfall in early March.

The remainder of the state, according to the SPI, was either near normal to moderately dry, with the exception of areas along the east slope of the Front Range in northeast Colorado where extremely dry conditions were indicated.

Snow Water Equivalent as a Percent of Average (%) for Colorado by River Basin as of Tuesday March 15, 2011



WEST SLOPE	EAST SLOPE
Yampa and White River Basins	Laramie & North Platte Basin
San Migual, Dolores, Animas & San Juan River Basins 95% Upper Rio Grande Basin	Statewide Avg113%

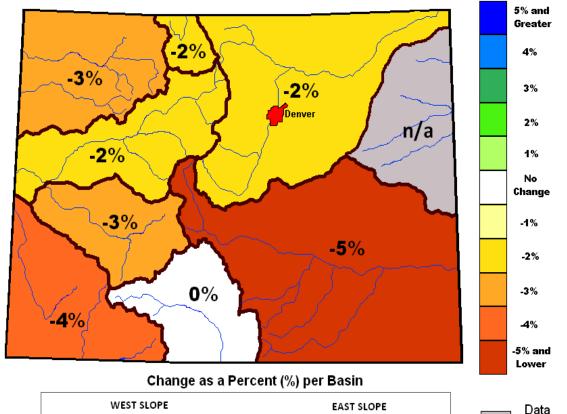
Source: USDA Natural Resources Conservation Service--Water and Climate, Portland, Oregon provisional data, subject to revision

Snow Water Equivalents

remained well above average for the major river basins in northwest and west central Colorado during this 30-day period. Snow water equivalents also remained above average at higher elevations of the South Platte River Basin in northeast Colorado.

Conversely, river basins in southwest, south central and southeast Colorado lost ground due in part to a lack of snowfall, and warmer than average temperatures resulting in greater rates of melting, sublimation and evaporation.

Change in Snow-Water Equivalent by Percent Per Colorado River Basin From February 17 to March 15, 2011



WEST SLOPE Yampa and White River Basins			· / /
Upper Colorado River Basin2% South Platte River Basin2% Gunnison River Basin5% Arkansas River Basin5% San Migual, Dolores, Animas & San Juan River Basins4%	WEST SLOPE		EAST SLOPE
	Upper Colorado River Basin	-2% -3% -4%	South Platte River Basin2%

Source: USDA Natural Resources Conservation Service--Water and Climate, Portland, Oregon provisional data, subject to revision

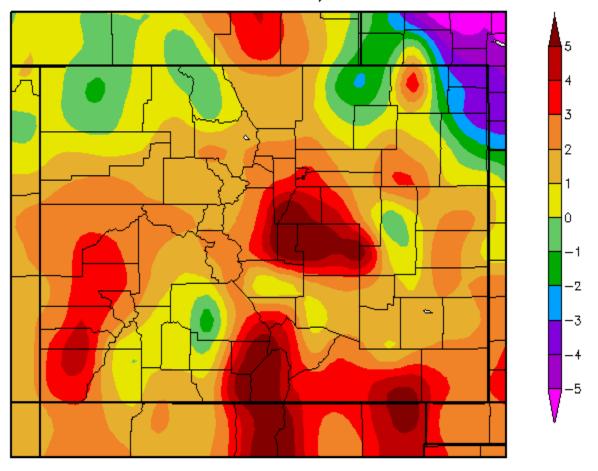
Snow Water Equivalents

decreased in the all major river basins of Colorado during the period February 17 to March 15, except in the Rio Grande Valley where the valley averaged snow water equivalent remained unchanged.

Not A∨ailable

Departure from Normal Temperature (°F) for Colorado

Feb. 18 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Center

Temperatures across Colorado during the 30day period ending March 19, 2011, resumed the warming trend observed earlier in the winter, particularly in the San Juan Mountains and the **Four Corners region in** southwest Colorado, the Palmer Divide/Rampart Range/Pikes Peak region in east central Colorado, and the Sangre de Cristo **Mountains and Raton** Pass region in southern Colorado.

The northwest plateau and Yampa River Valley region continued to experience colder than average temperatures, as well as the far northeast corner of the state.

Even as La Niña weakens, it may still continue to influence weather patterns across Colorado during the remainder of the 2011 spring season.





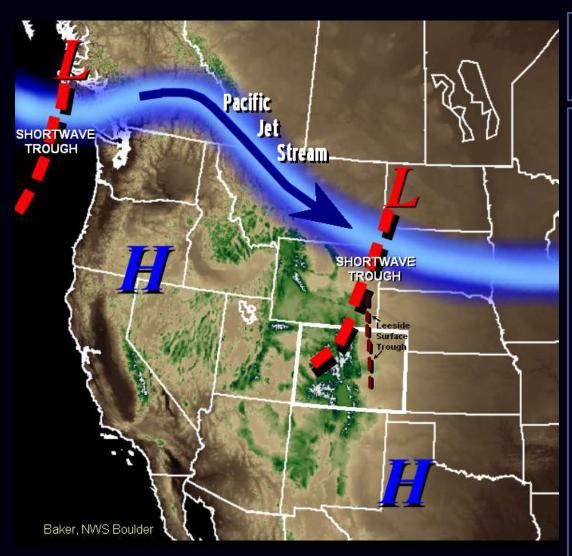


These desert-like weather conditions are often responsible for elevating the wildland fire danger to critical levels across Colorado, especially in the lee of the Front Range mountains.

Colorado may continue to feel the effects of a strong westerly or zonal flow aloft for at least another month as La Niña gradually loses its strength. Waves of moist Pacific air carried along by a ribbon of strong westerly winds aloft (e.g., the Pacific Jet Stream) will likely continue to produce periods of moderate to heavy mountain snowfall, on progressively higher west facing mountain slopes as temperatures rise through at least the end of April. While at the same time, this prevailing zonal flow pattern will also continue to generate periods of abnormally warm and very dry weather, accompanied by potentially damaging downslope (Chinook) wind events in areas east of the Continental Divide.

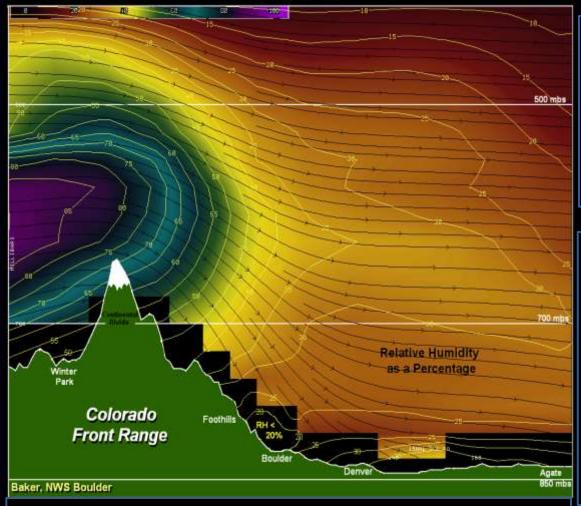
This same wind flow pattern will often strengthen and increase the frequency of gusty southwesterly "sand dune building" winds that normally develop during the spring in the San Luis Valley.

The Seasonal Shift in the Jet Stream



As La Niña continues to weaken, so too will the Pacific jet stream as it slowly migrates to higher latitudes.

Increasingly warm temperatures in the desert southwest and across the Great Basin beneath a strong ridge of high pressure aloft will cause the Pacific Jet Stream to shift northward over the Pacific Northwest and southwest Canada during the coming weeks. However, weak weather disturbances embedded within this strong flow aloft will occasionally dive southeastward across Wyoming and northern Colorado. As these disturbances or shortwave troughs brush by, they are likely to produce periods of rain and snow, possibly heavy at times, in the mountains and high valleys, and also strong, gusty northwesterly winds in the Front Range mountains and adjacent plains of eastern Colorado.



These desiccating downsloping winds often play a significant role in the growth and spread of wildland fire.

Strong and gusty downslope
(Chinook) winds such as those along
the Colorado Front Range, can
produce extremely low relatively
humidity and abnormally warm
temperatures regardless of the
time of day.

Relative humidity values less than five percent are not uncommon with these katabatic type winds. The effect of this downslope flow on humidity and temperature will often quickly decrease at greater distances from the base of the mountain. For instance, in a distance of only 10 miles, the RH could rise by as much as 30 percent!

Potential Impacts on the Colorado Front Range During the Final Days of La Niña



Record Heat



A Growing Risk of Wildland Fires



Abnormally Dry
Conditions
Leading to Serious
Drought



Drastically Reduced Runoff to Area Lakes and Reservoirs



Strong and Potentially Damaging Downslope Wind Storms

U.S. Drought Monitor March 15, 2011 Colorado Close-up Intensity: Drought Impact Types: D0 Abnormally Dry Delineates dominant impacts D1 Drought - Moderate A = Agricultural (crops, pastures, USDA grasslands) D2 Drought - Severe D3 Drought - Extreme H = Hydrological (water) D4 Drought - Exceptional

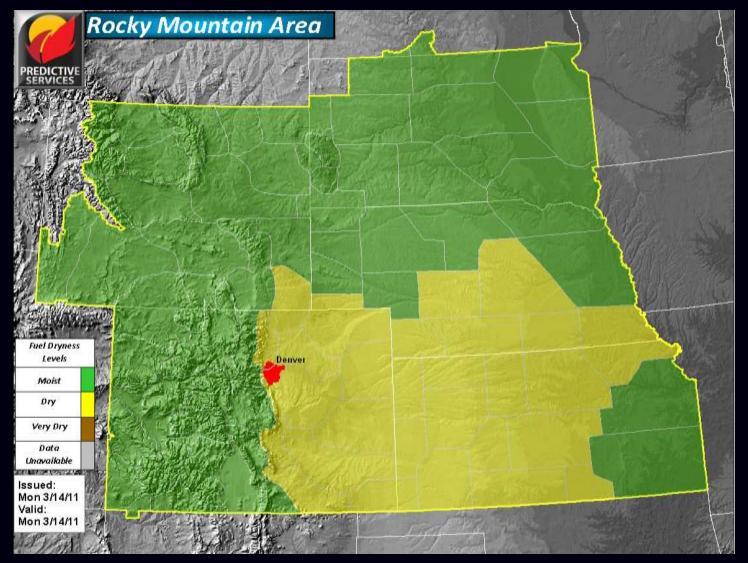
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, March 17, 2011
Author: Laura Edwards, Western Regional Climate Center

According to the U.S. Drought Monitor, moderate (D1) to severe (D2) drought conditions encompass essentially all of eastern Colorado as of the middle of March. These drought conditions are both agricultural and hydrological in scope.

Abnormally dry (D0) and moderate (D1) drought conditions also exist in the San Luis Valley of southern Colorado, along the east facing slopes of the San Juan, La Garita, Rampart and Front Range mountains, and across the far northeast corner of the state.



Fuels such as short and tall grasses and shrubs continue dry out in areas east of the central Rocky Mountains due in large part to the recent abnormally dry, warm and windy conditions. As of mid-March, Predictive Services in Boise, Idaho indicated a wide swath of dry fuels from eastern Colorado, eastward across Kansas and southern Nebraska to the Missouri River.

Seasonal Significant Wildland Fire Potential Outlook - April to June 2011



Predictive Services at the National Interagency Coordination Center in Boise, Idaho predicts that southeast Colorado will see the potential for significant wildland fire increasing to above normal during the upcoming spring.

Other parts of Colorado, such as the northeast plains and the San Luis Valley, may also see a significant increase in wildland fire potential during this period; although not indicated on this map.

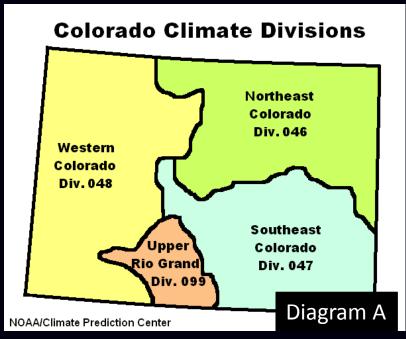


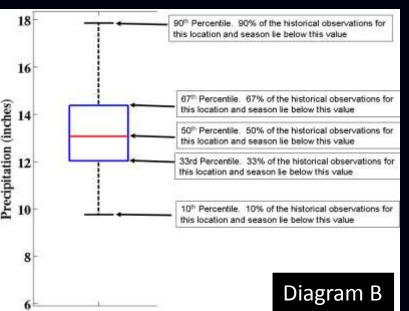
of additional resources from outside the area in which the fire situation originates.





Map produced by Predictive Services, National Interagency Coordination Center Boise, Idaho Issued February 1, 2011 Next issuance March 1, 2011





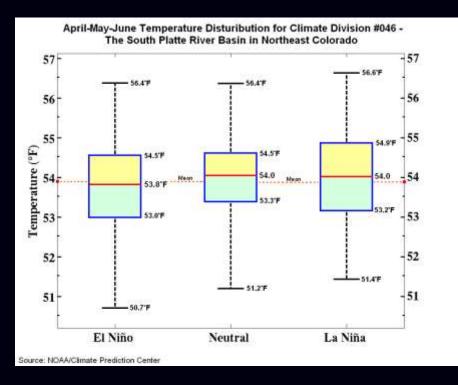
<u>Diagram A</u>: Colorado is presently subdivided into four climate divisions. Climate divisions 046, 047 and 099 are located east of the Continental Divide.

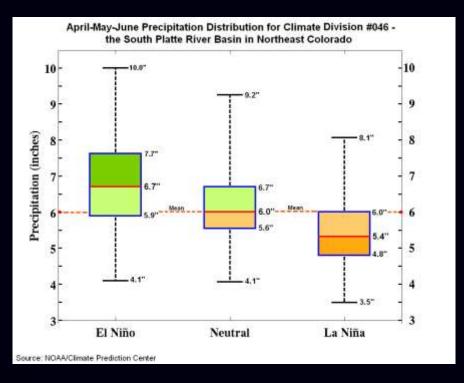
NOAA's Climate Prediction Center (CPC) has produced historical distributions of 3-month temperature and precipitation associated with three different ENSO categories — El Niño, La Niña and Neutral events — for each of these climate divisions.

<u>Diagram B</u>: One method CPC uses to display these historical temperature and precipitation distributions is with the use of an ENSO box and whisker analysis plot.

The red line inside the ENSO box represents the mean or 50th percentile of the data (temperature or precipitation) distribution. Approximately 34% of the total observations fell within the ENSO box, and the remaining observations (or 66%) outside of the box.

ENSO Box and Whisker Analysis Plots for Climate Division #046 – The South Platte River Basin in Northeast Colorado for the 3-Month Climate Season of April-May-June





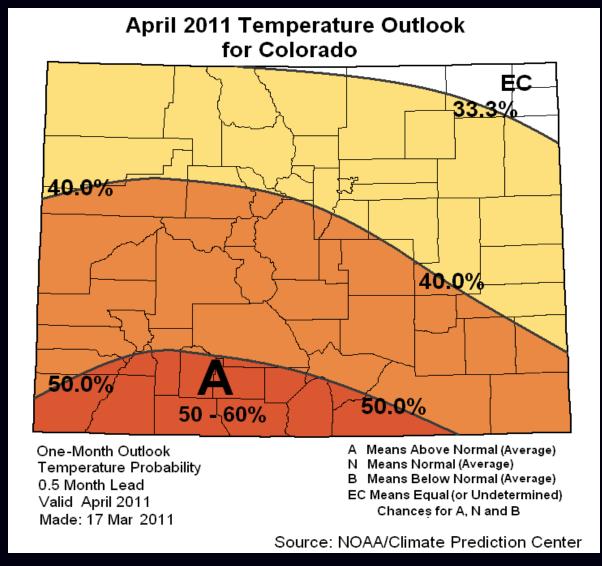
The three temperature plots in the diagram above reveal little meaningful difference in the historical distribution of temperature for this 3-month period. However, it could be suggested that the overall temperature range for climate division #046 was slightly warmer during La Niñas than during El Niño and neutral (non-ENSO) events.

The difference in the historical distribution of precipitation during El Niño, La Niña and neutral events is more evident. The three plots show that the 3-month climate season April-May-June for Colorado climate Division #046 was noticeably drier during previous La Niñas compared to that observed during past El Niño and neutral events.

Temperature and Precipitation Outlooks For April-May-June 2011 Issued by NOAA's Climate Prediction Center



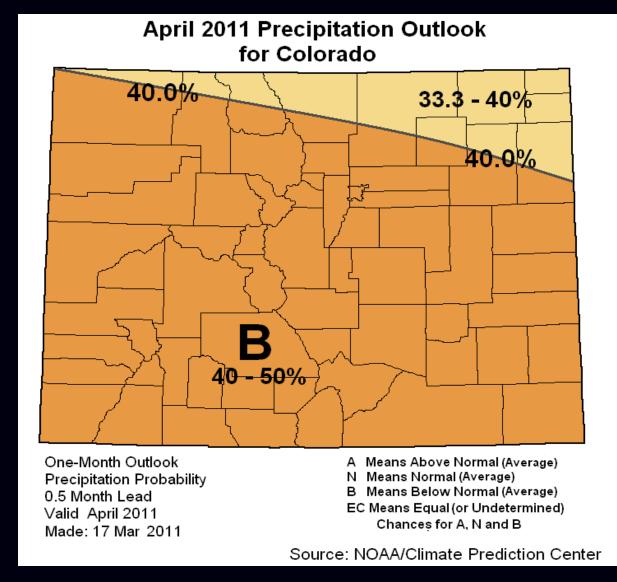




The Trend is
Towards Warmer
Temperature,
Especially for the
Western Slope

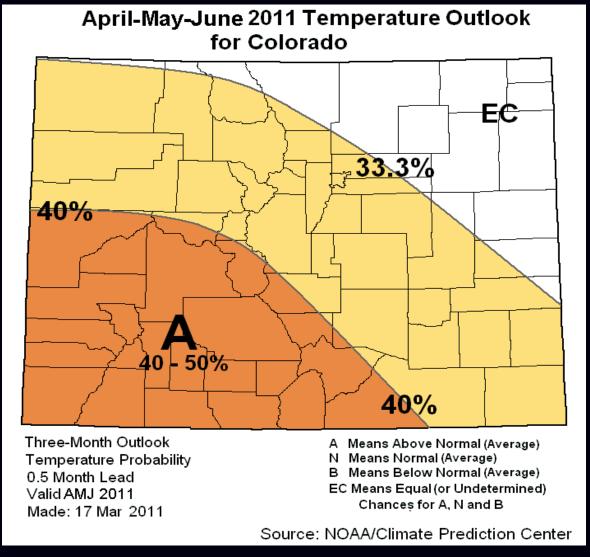
A shift to warmer than normal temperatures on the western slope of Colorado could accelerate the melting of an abnormally deep snowpack, possibly producing unusually high water levels on area water ways.

For the month of April, the outlook from CPC is for at least a 50% chance of above normal (average) temperature in an narrow area along the New Mexico border, including southern portions of the San Juan Mountains, a 40 to 50% chance of above average temperature across central portions of Colorado, and a 33.3 to 40% chance of above temperature for the remainder of the state, except in the extreme northeast where EC is indicated.



The increase in confidence for below average precipitation expressed in the latest outlook from CPC may be attributed to a northward displacement in the storm track (the Pacific Jet Stream) and to the formation of a strong blocking high pressure ridge pattern that often occurs over the western continental United States this time of year.

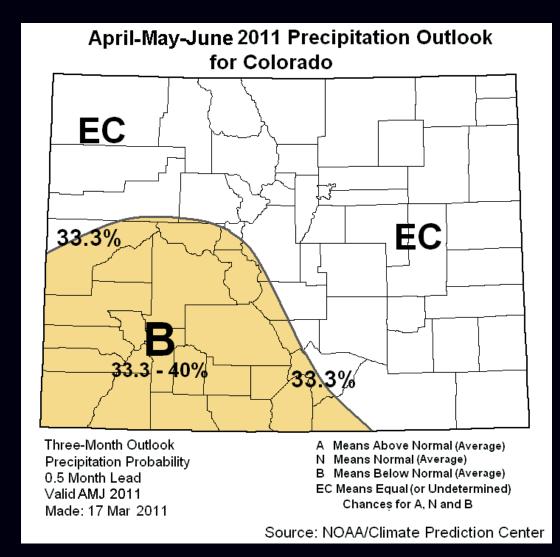
The outlook from CPC is for a 40 to 50% chance of below normal (average) precipitation for all except the northeast corner of Colorado during the month of April. In the far northeast corner of the state, the outlook is for a 33.3 to 40% chance of below average precipitation.



The uncertainty (EC) in the temperature outlook for the northeast corner of the state may be traced to the uncertainty in the position of the Pacific Jet Stream, specifically during the latter half of April and May.

The close proximity of a strong northwest-to-southeast oriented Pacific jet stream has been blamed for all types of wild weather during the latter half of spring—damaging hail storms, surprise snow squalls, sudden down pours, damaging thunderstorm winds and even tornadoes.

For April, May and June, the outlook from CPC is for a 40 to 50% chance of above normal (average) temperature across the southwest corner of Colorado, a 33.3 to 40% chance of above average temperature across the northwest, central and southeast parts of the state, and an equal or undetermined chance for above, below or near average temperature across the northeast corner.



The symbol EC is often used by CPC to express an equal chance for above, below and near normal precipitation or temperature. It may also denote a degree of uncertainty in the outlook.

As the ENSO signal weakens and becomes indistinguishable from "usual" climate drivers (i.e., the seasons, day length, etc.) the ability to assign either above, below or near normal to an outlook become somewhat more difficult.

For this three month period, the outlook from CPC is for a 33.3 to 40% chance of below normal (average) precipitation across the southwest one-quarter of Colorado, and an equal chance of above, below and near average precipitation across the remainder of the state.

Summary

- La Niña continues to weaken in the central and eastern tropical Pacific Ocean as indicated by the recent warming of sea surface temperatures anomalies in the region.
- The latest forecasts, from nearly two dozen ENSO-climate models, continue to indicate an equal chance of ENSO-neutral and weak La Niña conditions in the tropical Pacific Ocean by late this spring.
- Even as La Niña continues to weaken, it is possible that it will continue to play an important role on local weather patterns across Colorado throughout this spring. Impacts from these weather anomalies include producing significant wildland fire danger, particularly in areas east of the Continental Divide and the potential for heavy runoff from rapid mountain snow melt in areas west of the Divide.
 - The latest outlook prepared by NOAA's Climate Prediction Center (CPC) indicates better than a 33% chance of above normal (average) temperature and below normal (average) precipitation across nearly all of the Colorado during the months of April, May and June of 2011. Most notable change in this latest outlook is the shift to warmer and drier conditions west of the Continental Divide.



